

Chart Cooler Service Company

AIR COOLED HEAT EXCHANGER SPECIFICATION SHEET

P.O. Box 581928 Tulsa, Ok 74158 Ph 918.834.0002 Fax 918.834.0128

1				Date:	1/20/11	Rev.	
2	Customer	Denbury Onshore, LLC		Item No.	A-101		
3	Plant Location	Brandon, Mississippi	Job No.	WRB#464	Ref. No.	12411	
4	Service	Gas Cooler		P.O. No.	WRB#464		
5	Size and Type	Model: H144	FORCED Draft	No. Bays	1		
6	Surface/Unit - Finned Tube	62537.8 ft2	;Bare Tube	2914.67 ft2			
7	Heat Exchanged	6,658,860 Btu/h	MTD, Eff.	23.4 °F			
8	Transfer Rate-Finned Tube	4.558 ;Bare Tube, Service	97.79	Clean	110.17 Btu/h.ft2.F		

PERFORMANCE DATA - TUBE SIDE

10	Fluid Name	Gas	Vapor Ref. Temp.	°F	120.0 / 150.0		
11	Total Fluid In	lb/h	241000	Specific Heat	Btu/lb.F	1.2205 / 0.6618	
12	Vapor	lb/h	241000	Viscosity	cP	0.03629 / 0.0274	
13	Liquid	lb/h	0	Conductivity	Btu/h.ft.F	0.03129 / 0.02301	
14	Noncond	lb/h		Molecular Weight	43.9 / 43.9		
15	Steam	lb/h		Liquid Ref. Temp.	°F	32.0 / 32.0	
16	Water	lb/h		Specific Heat	Btu/lb.F	0.0 / 0.0	
17	Fluid Cond./Vapzd.	lb/h	0	Viscosity	cP	0.0 / 0.0	
18	Temperature In/Out	°F	150.0 / 120.0	Conductivity	Btu/h.ft.F	0.0 / 0.0	
19	Pressure	psia	1614.69	Density	lb/ft3	0.0 / 0.0	
20	Velocity In/Out	ft/s	6.17 / 4.10				
21	Press. Drop Allow/C	psi	2.5 / 1.954	Fouling resistance	h.ft2.F/Btu	0.001	

PERFORMANCE DATA - AIR SIDE (Air)

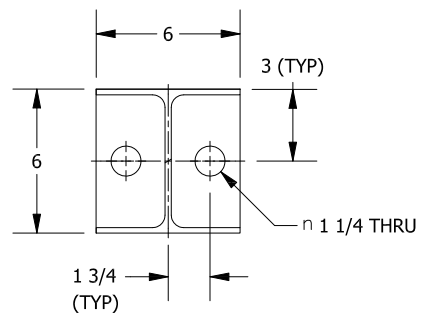
23	Air Quantity, Total	lb/h	1584830	Altitude above Sea Level	ft	270.0	
24	Air Quantity/Fan	acfm	188023	Temperature In (Dry Bulb)	°F	100.0	
25	Actual Static Press	in H2O	0.518	Temperature Out	°F	117.51	
26	Face Velocity	sfm	630.0	Min. Design Ambient	°F	20.0	
27	Max Mass Velocity	lb/h.ft2	5,980	Fan Air Temperature	°F	100.0	

DESIGN - MATERIALS - CONSTRUCTION

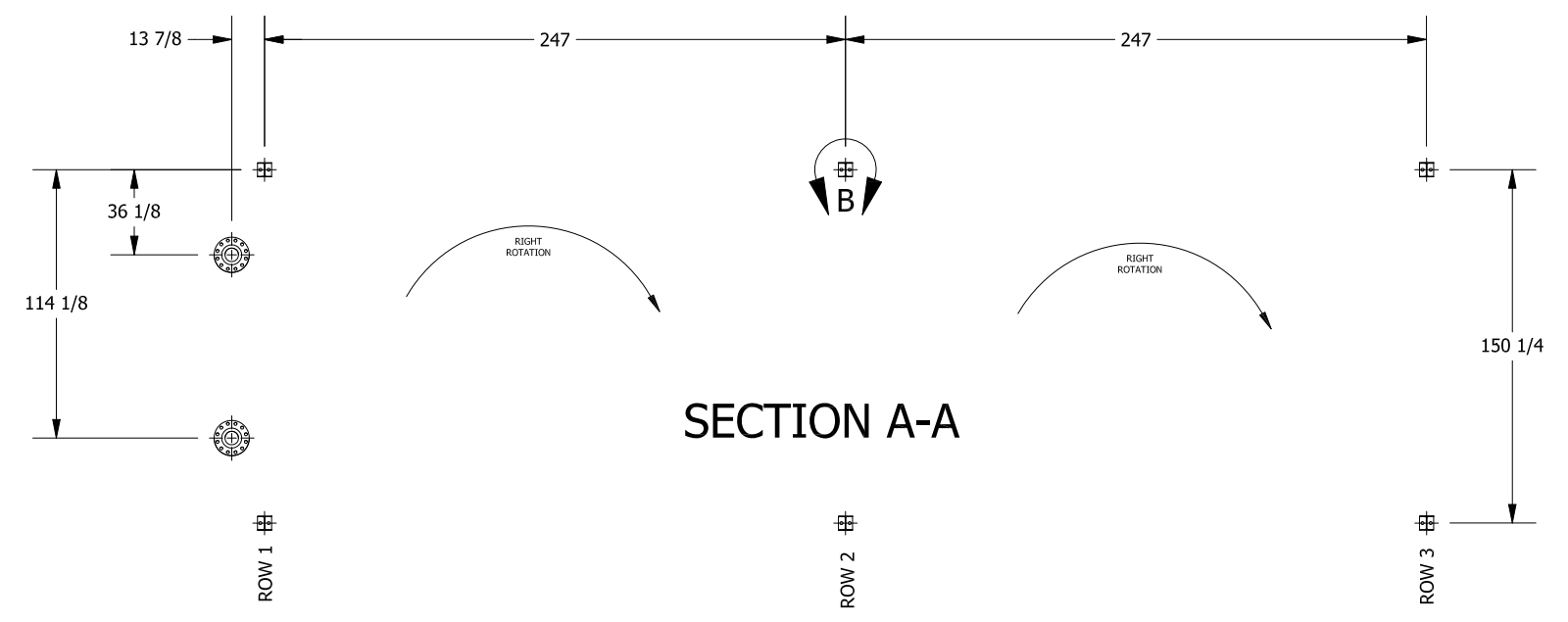
29	Design Pressure	2000.0 psig	Test Pressure	Per Code	Design Temperature	150.0 / -20	°F
30	TUBE BUNDLE		HEADER, Type	Plug Box	TUBE, Material	SA-249 TP316	
31	Size	12.911 x43.0	Material	SA-240 316		Wld	
32	No./Bay 1	No. Rows 4	No. Passes 2		OD 1.0	Thick 0.065	in
33	Arrangement		Slope 0.0	in/ft	No./Bundle	266	
34	Bundles	1 Parallel	Plug Material	SA-182 F316	Length	43.0 ft	
35	Bays	1 Parallel	Gasket Material	SS	Pitch	2.313 in	
36	MISCELLANEOUS		Corrosion Allow.	0.0 in	Fin, Type	TWF	
37	Struct. Mount	Grade c/c	No. Size In Nozz.	2 - 6" 900# RF-WN	Material	Aluminum	
38	Surf Prep	SSPC-2	No. Size Out Nozz.	2 - 6" 900# RF-WN	OD 2.25	Thk. 0.015	in
39	Surf Finish	Galvanize	Vent and Drain	1" 6000#	No./in 10.0	Fin Design Temp	
40	Hail Guards	None	TI	PI	Code - ASME	Stamp	Yes
41	Louvres / Actuators	None	Header Prep	SSPC-SP-1	X-RAY	No	PWHT No
42	Vibration Switches	Murphy VS2-EX	Header Finish	None	SPECS.	NB	API-661 No

MECHANICAL EQUIPMENT

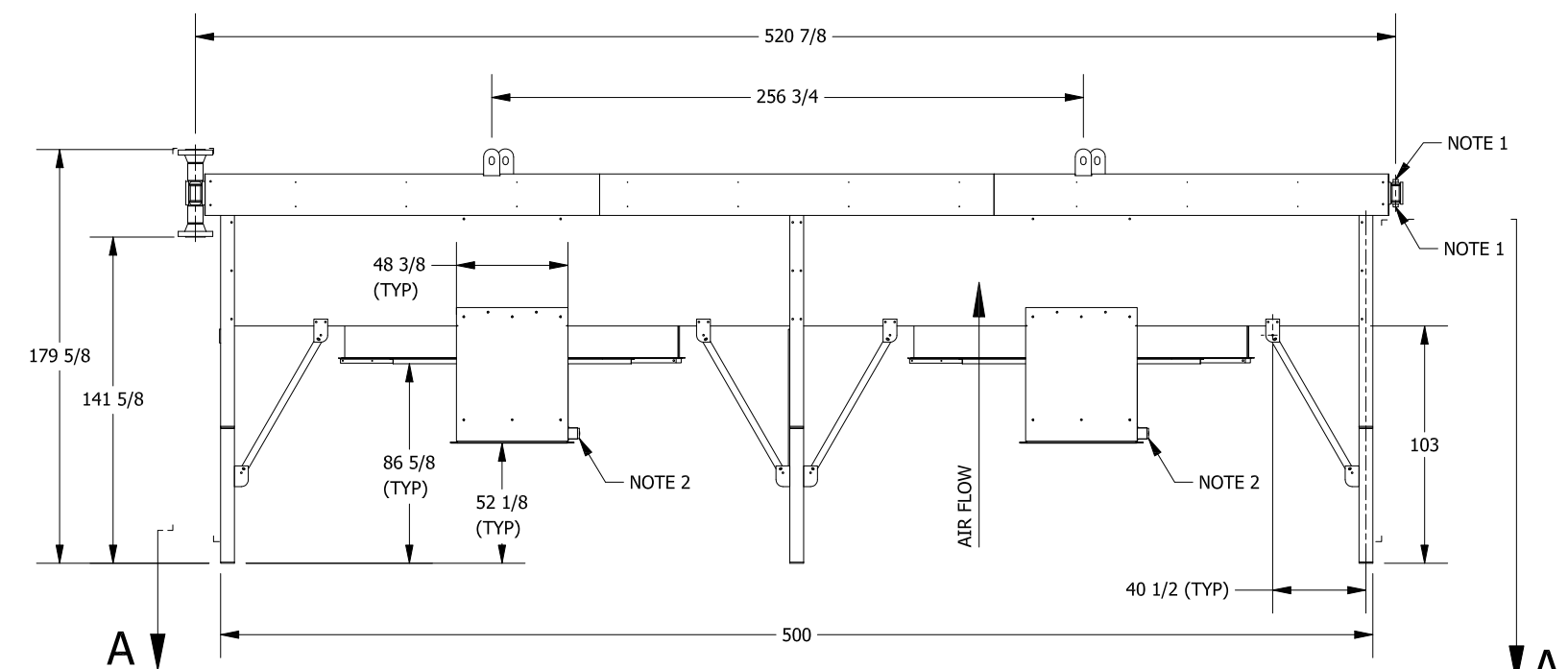
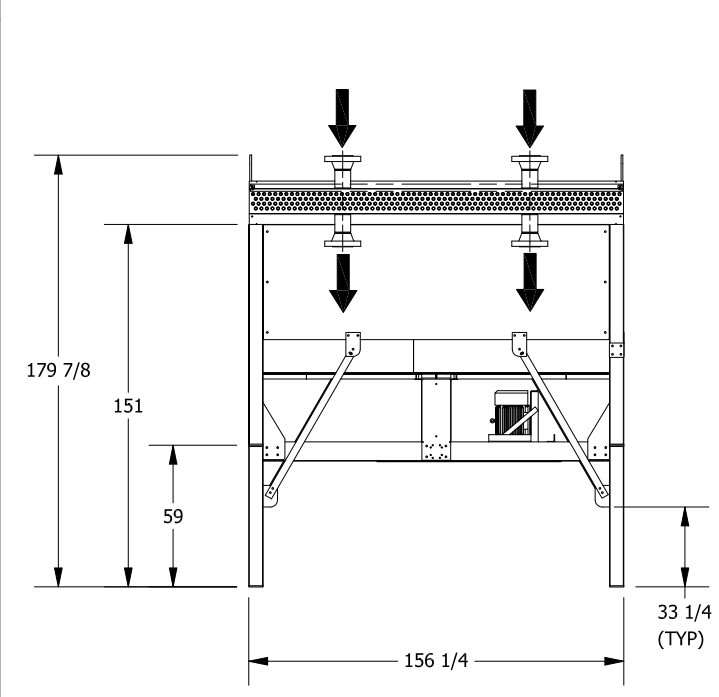
44	Fan Mfg	Moore	Driver		Speed Reducer		
45	Model Class	10000 Series 42 SC	Type	NEMA-1.15SF-Premium Eff.	Type	V-Belt	
46	No./ Bay	2	Rev/Min	271	Mfg.	Gates	
47	Dia. ft	12	No. Blades	6	No/Bay	2	Frame 286T
48	Pitch	22.28	Manual		Model	4/5VX1400	QD4/5V37.50
49	Mat'l:Blade	AL	Hub	AL	hp /Driver	30	QD4/5V5.90
50	hp/Fan, Design	26.92	Rev/Min	1750	AGMA Rating, SF	1.4	
51	hp/Fan, Min Amb	31.41	Enclosure	TEFC Ins F TR B	Ratio	6.458	
52	Plot Area	43 x 13.020	Volt;Phase;Cycle	460/3/60	Support	Structure	
53	Walkways	Width	Type		Total Weight (per bay)	35970	Dry
54	Inlet				Coil Vol	447	Gal
55	Outlet				Wind Load	30 PSF	
56	Drive				Seismic Zone	0	
57	Deisgned using HTRI						
58							
60							



DETAIL B
1/2" THK. BASE PLATE



SECTION A-A



Drive		Motor		Fan	
Fan Sheave	QD4/5V37.50	HP	30	Make	Moore
Motor Sheave	QD4/5V5.90	RPM	1750	Dia. (ft)	12
Belts	4/5VX1400	Frame	286T	Model	10000 - 42 SC
Center Dist.	31.92	Enclosure	TEFC	Num Blades	6
		Volts	460	Pitch	22.28
		Frequency	60	ACFM/Fan	187627
		Phases	3	RPM	271
				HP	26.92

DIMENSION TOLERANCE: 1/8" EVERY 10'

COIL ORDER (Left to Right) w/ COIL VOLUMES
Gas Cooler A-101 (Coil 1) 447 gal.

- NOTES:
1. 1"-6000# HALF CPLG.
2. MURPHY VS2-EX VIBRATION SWITCH.

CERTIFIED
RELEASED FOR FABRICATION

FINISH

STRUCTURE:Galvanized HEADERS:Metalyze

PO#: WRB#464 Project: TBD UNITS:3

CHART COOLER SERVICE COMPANY
TULSA, OK

DRAWN BY: DAH APPROVED BY: CRM
SCALE: NONE DATE:1/25/2011

Denbury Onshore, LLC
EQUIPMENT OUTLINE

Model: H144-43 DWG: 12411-O

Wet/Operating Weight	39700	39700	88 mph		Snow Load 0	lbs/sq-ft		Platform 100		lbs/sq-ft Live	
Dry Weight	36000		Wind 30 psf		Seis Zone 0						
Column Load (KIPS)	Dry Dead	Wet Dead	Wind Vert	Wind Horiz	Seis Vert	Seis Horiz	Snow Plat	Noz Vert	Noz Horiz	Total	
Row 1/Column	4.5	5.0	2.1	1.1	0.0	0.0	0.0	2.3	2.2	9.4	
Row 2/Column	9.0	10.0	4.2	2.2	0.0	0.0	0.0	0.0	0.0	14.2	
Row 3/Column	4.5	5.0	2.1	1.1	0.0	0.0	0.0	0.0	0.0	7.1	

Coil No.	Service	Des P (psig)	Des Temp (°F)	CA (in)	ASME Code	NB Reg.	Qty	Inlet Nozzle Size (in)	Inlet Nozzle Rating (psi)	Outlet Nozzle Qty	Outlet Nozzle Size (in)	Outlet Nozzle Rating (psi)	Top of Coil
1	Gas Cooler A-101	2000	150	0	Yes	yes	2	6	900#-RF	2	6	900#-RF	Open



Chart Cooler Service Company, Inc.
 3515 Dawson Road
 Tulsa, Oklahoma 74115
 (918) 834-0002

Customer: **Denbury Onshore, LLC**
 Customer P.O. No.: **WRB#464**
 Item No.: **A-101**
 Service: **Gas Cooler**

Date: **2/11/2011**

Approved: *[Signature]*

Header Design Calculations Rev 1
 Per 2010 ASME Code Section VIII Division 1 Appendix 13
 Fig. 13-2(a) Vessels of Rectangular Cross Section - Sketch (7)

UG-22 has been considered for specified loadings and no additional calculations are required.

Job No.: **12411-01 Inlet-Outlet**

Short Side: **Cover**

Design Press. (P): **2000 PSI** Min. Test Press.: **2600 PSI**

Design Temp.: **150 °F** / **-20 °F** MDMT

Material: **SA-240 - 316 (UNS No. S31600)**

Allow. Membrane Stress: **20000 PSI**

Allow. Bending and Total Stress: **30000 PSI (1.5 x Membrane Stress)**

Corrosion Allowance: **0 in.**

Long side Sheet Thickness: **1.25 in.**

Long side Sheet Thickness Less Corr. Allow. = $t_2 = 1.25$ in.

Short side Thickness: **1.25 in.**

Short side Thickness Less Corr. Allow. = $t_1 = 1.25$ in.

Stay Plate Thickness: **0.375 in.**

Stay Plate Thickness Less Corr. Allow. = $t_3 = 0.375$ in.

H (corroded) = **5.875 in.**

h (corroded) = **3.625 in.**

Horizontal Tube Pitch (*pitch*) = **2.313 in.**

D (Hole diameter) = **1.09375 in.**

$E = 1.0$ (see 13-4-g-1)

Bending and Membrane Efficiencies, $e_b = e_m = \frac{pitch - D}{pitch} = 0.52713$

Short side $e_b = e_m = 1$

Long side $e_b = e_m = 0.52713$

$c = (c_1 \text{ or } c_2)$; $c_1 = \frac{t_1}{2} = 0.625$; $c_2 = \frac{t_2}{2} = 0.625$

$\alpha = \frac{H}{h} = 1.62069$

$I_1 = \frac{t_1^3}{12} = 0.16276 \text{ in.}^4$

$I_2 = \frac{t_2^3}{12} = 0.16276 \text{ in.}^4$

$K = \left(\frac{I_2}{I_1} \right) \alpha = 1.62069$

Job No.: 12411-01 Inlet-Outlet

(1) Membrane Stress

$$\text{Short-Side Plates } S_m = \frac{Ph}{4t_1 e_m} \left\{ 4 - \left[\frac{2+K(5-\alpha^2)}{1+2K} \right] \right\} = 3801 \text{ PSI}$$

$$\text{Long-Side Plates } S_m = \frac{PH}{2t_2 e_m} = 8916 \text{ PSI PSI}$$

$$\text{Stay Plates } S_m = \frac{Ph}{2t_3 E} \left[\frac{2+K(5-\alpha^2)}{1+2K} \right] = 13325 \text{ PSI}$$

(2) Bending Stress

$$\text{Short-Side Plates } (S_b)_N = \pm \frac{Pc_1}{24I_1 e_b} \left[-3H^2 + 2h^2 \left(\frac{1+2\alpha^2 K}{1+2K} \right) \right] = -14270 \text{ PSI}$$

$$(S_b)_Q = \pm \frac{Ph^2 c_1}{12I_1 E} \left(\frac{1+2\alpha^2 K}{1+2K} \right) = 18865 \text{ PSI}$$

$$\text{Long-Side Plates } (S_b)_M = \pm \frac{Ph^2 c_2}{12I_2 e_b} \left[\frac{1+K(3-\alpha^2)}{1+2K} \right] = 6038 \text{ PSI}$$

$$(S_b)_Q = \pm \frac{Ph^2 c_2}{12I_2 E} \left(\frac{1+2\alpha^2 K}{1+2K} \right) = 18865 \text{ PSI}$$

(3) Total Stress

$$\text{Short-Side Plates } (S_T)_N = S_m + (S_b)_N = 18072 \text{ PSI}$$

$$(S_T)_Q = S_m + (S_b)_Q = 22666 \text{ PSI}$$

$$\text{Long-Side Plates } (S_T)_M = S_m + (S_b)_M = 14954 \text{ PSI}$$

$$(S_T)_Q = S_m + (S_b)_Q = 27781 \text{ PSI}$$

$$\text{Stay Plates } S_T = S_m = 13325 \text{ PSI PSI}$$

(4) End Plate Stress (per UG 34)

d (corroded) = 5.875 in.

D (corroded) = 3.625 in.

c = 0.2 (see 13-4(f))

End Plate Thickness: 0.75 in.

End Plate Thickness Less Corr. Allow. = t_{ep} = 0.75 in.

$$Z = 3.4 - 2.4 \left(\frac{d}{D} \right) = 1.91915 \quad \text{Max } 2.5$$

$$S = \frac{cd^2 Z P}{t_{ep}^2} = 17933 \text{ PSI}$$



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 3515 Dawson Road
 Tulsa, Oklahoma 74115
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Customer: Denbury Onshore, LLC
 Customer P.O. No.: WRB#464
 Item No.: A-101
 Service: Gas Cooler

Date: 1/24/2011

Approved:

Header Design Calculations Rev 1
 Per 2010 ASME Code Section VIII Division 1 Appendix 13
 Fig. 13-2(a) Vessels of Rectangular Cross Section - Sketch (7)

UG-22 has been considered for specified loadings and no additional calculations are required.

Job No.: 12411-01 Return

Short Side: Cover

Design Press. (P): 2000 PSI

Min. Test Press.: 2600 PSI

Design Temp.: 150 °F / -20 °F MDMT

Material: SA-240 - 316 (UNS No. S31600)

Allow. Membrane Stress: 20000 PSI

Allow. Bending and Total Stress: 30000 PSI (1.5 x Membrane Stress)

Corrosion Allowance: 0 in.

Long side Sheet Thickness: 1 in.

Long side Sheet Thickness Less Corr. Allow. = $t_2 = 1$ in.

Short side Thickness: 0.875 in.

Short side Thickness Less Corr. Allow. = $t_1 = 0.875$ in.

Stay Plate Thickness: 0.5 in.

Stay Plate Thickness Less Corr. Allow. = $t_3 = 0.5$ in.

H (corroded) = 4.25 in.

h (corroded) = 3.5625 in.

Horizontal Tube Pitch (*pitch*) = 2.313 in.

D (Hole diameter) = 1.09375 in.

$E = 1.0$ (see 13-4-g-1)

Bending and Membrane Efficiencies, $e_b = e_m = \frac{pitch - D}{pitch} = 0.52713$

Short side $e_b = e_m = 1$

Long side $e_b = e_m = 0.52713$

$c = (c_1 \text{ or } c_2)$; $c_1 = \frac{t_1}{2} = 0.4375$; $c_2 = \frac{t_2}{2} = 0.5$

$\alpha = \frac{H}{h} = 1.19298$

$I_1 = \frac{t_1^3}{12} = 0.05583 \text{ in.}^4$

$I_2 = \frac{t_2^3}{12} = 0.08333 \text{ in.}^4$

$K = \left(\frac{I_2}{I_1}\right)\alpha = 1.78078$

Job No.: 12411-01 Return
 (1) Membrane Stress

$$\text{Short-Side Plates } S_m = \frac{Ph}{4t_1 e_m} \left\{ 4 - \left[\frac{2 + K(5 - \alpha^2)}{1 + 2K} \right] \right\} = 4408 \text{ PSI}$$

$$\text{Long-Side Plates } S_m = \frac{PH}{2t_2 e_m} = 8063 \text{ PSI PSI}$$

$$\text{Stay Plates } S_m = \frac{Ph}{2t_3 E} \left[\frac{2 + K(5 - \alpha^2)}{1 + 2K} \right] = 13073 \text{ PSI}$$

(2) Bending Stress

$$\text{Short-Side Plates } (S_b)_N = \pm \frac{Pc_1}{24I_1 e_b} \left[-3H^2 + 2h^2 \left(\frac{1 + 2\alpha^2 K}{1 + 2K} \right) \right] = -13334 \text{ PSI}$$

$$(S_b)_Q = \pm \frac{Ph^2 c_1}{12I_1 E} \left(\frac{1 + 2\alpha^2 K}{1 + 2K} \right) = 22054 \text{ PSI}$$

$$\text{Long-Side Plates } (S_b)_M = \pm \frac{Ph^2 c_2}{12I_2 e_b} \left[\frac{1 + K(3 - \alpha^2)}{1 + 2K} \right] = 20099 \text{ PSI}$$

$$(S_b)_Q = \pm \frac{Ph^2 c_2}{12I_2 E} \left(\frac{1 + 2\alpha^2 K}{1 + 2K} \right) = 16885 \text{ PSI}$$

(3) Total Stress

$$\text{Short-Side Plates } (S_T)_N = S_m + (S_b)_N = 17742 \text{ PSI}$$

$$(S_T)_Q = S_m + (S_b)_Q = 26462 \text{ PSI}$$

$$\text{Long-Side Plates } (S_T)_M = S_m + (S_b)_M = 28161 \text{ PSI}$$

$$(S_T)_Q = S_m + (S_b)_Q = 24948 \text{ PSI}$$

$$\text{Stay Plates } S_T = S_m = 13073 \text{ PSI PSI}$$

(4) End Plate Stress (per UG 34)

d (corroded) = 4.25 in.

D (corroded) = 3.5625 in.

c = 0.2 (see 13-4(f))

End Plate Thickness: 0.625 in.

End Plate Thickness Less Corr. Allow. = t_{ep} = 0.625 in.

$$Z = 3.4 - 2.4 \left(\frac{d}{D} \right) = 1.38824 \text{ Max } 2.5$$

$$S = \frac{cd^2 Z P}{t_{ep}^2} = 18042 \text{ PSI}$$



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Customer: Denbury Onshore, LLC
Customer P.O. No.: WRB#464
Item No.: A-101
Service: Gas Cooler

Date: 2/11/2011

Approved: 

Tube and Nozzle Design Calculations Rev 1
Per 2010 ASME Code Section VIII Division 1

UG-22 has been considered for specified loadings and no additional calculations are required.
Job No.: 12411-01

Design Press. (P): 2000 PSI
Design Temp.: 150 °F / -20 °F MDMT
Corrosion Allowance (CA): 0 in.
Weld Efficiency (E): 1.0

Tubes

Tube Material: SA-249 - TP316 (UNS No. S31600)
Allowable Stress (S): 17000 PSI
Tube Outside Diameter: 1 in.
Tube Outside Radius (R_o): 0.5 in.

$$t_{req'd} = \frac{PR_o}{SE + 0.4P} = 0.0562 \text{ in.}$$

Tube thickness used: 0.065 in.

Nozzles

Nozzle Material: SA-312 - TP316 (UNS No. S31600)
Nozzle Allowable Stress (S): 20000 PSI

Inlet Nozzle

Inlet Nom. Pipe Size: 6"
Inlet Outside Radius (R_o): 3.3125 in.

$$t_{req'd} = \left(\frac{PR_o}{SE + 0.4P} + CA \right) \div 0.875 = 0.364 \text{ in.}$$

Uncorroded Inlet Nozzle thickness used: 0.432 in.

Outlet Nozzle

Outlet Nom. Pipe Size: 6"
Outlet Outside Radius (R_o): 3.3125 in.

$$t_{req'd} = \left(\frac{PR_o}{SE + 0.4P} + CA \right) \div 0.875 = 0.364 \text{ in.}$$

Uncorroded Outlet Nozzle thickness used: 0.432 in.